

Errata list

Last updated Sunday 13th October, 2019.

Handbook

Page 73 Item 4(i) In the displayed equation the left-hand side should be the vector $\mathbf{x}$ rather than a scalar x , so the equation should read:

$$\mathbf{x}(t) = C_1 \mathbf{v}_1 \cos(\omega_1 t + \phi_1) + \cdots + C_n \mathbf{v}_n \cos(\omega_n t + \phi_n),$$

Page 76 Item 8(b) In the final sentence the Jacobian matrix should be evaluated at the equilibrium point (X, Y) rather than the general point (x, y) , so the sentence should read:

where $x(t) = X + p(t)$ and $y(t) = Y + q(t)$, and $\mathbf{J} = \mathbf{J}(X, Y)$.

Page 78 Item 13(b) The final sentence the should refer to the nullclines for $\dot{x}$ and $\dot{y}$ rather than the nullclines for x and y , so the sentence should read:

(Note that the equilibrium points occur where nullclines for $\dot{x}$ and $\dot{y}$ intersect — this is a useful check.)

Page 87 Item 2 In the first line the vector field $\mathbf{F}(\rho, \theta, z)$ should be $\mathbf{F}(\rho, \phi, z)$, so the first sentence should start:

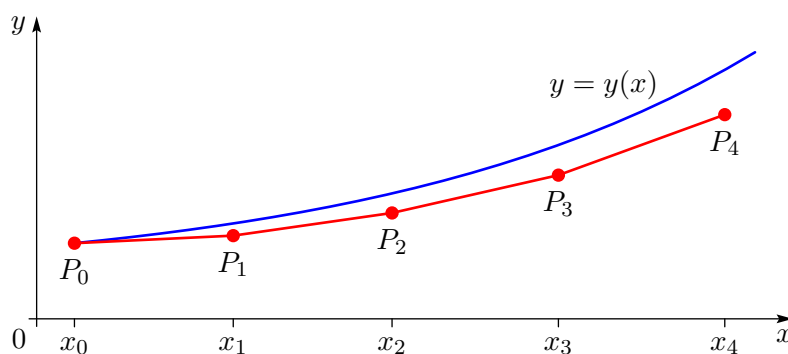
The **divergence** of a vector field $\mathbf{F}(\rho, \phi, z) = F_\rho \mathbf{e}_\rho + F_\phi \mathbf{e}_\phi + F_z \mathbf{e}_z$

Page 88 Item 9 In the displayed equation the first r should be bold, so that the equation should read:

$$\int_{BA} \mathbf{F}(\mathbf{r}) \cdot d\mathbf{r} = - \int_{AB} \mathbf{F}(\mathbf{r}) \cdot d\mathbf{r}$$

Unit 1

Page 27 Figure 9 The points on the approximate solution P_i should be below the exact solution for the illustrative example shown, so the correct figure should look like:



Page 88	Solution to Exercise 37(b)	In the final step of the solution there is a sign error in the first term. The final line should read:
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$$y = 2e^x + 2e^{2x} - 4xe^x = (2 - 4x)e^x + 2e^{2x}.$$

Unit 2

Page 102	Penultimate paragraph	The vector b mentioned in the text should be the vector c shown in Figure 12. The middle three sentences of the paragraph should read:
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Draw the two vectors **a** and **c** with the same beginning point *O*. Complete the parallelogram OP_1QP_2 . Then the resultant vector **a** + **c** is the vector on the diagonal of the parallelogram.

Page 115	Solution to Example 4(c)	When evaluating the dot product in the second line of the displayed equation the rightmost $\sqrt{2}$ should be negative, so the line should read:
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$$= (1 \times 1) + (1 \times 1) + (\sqrt{2} \times (-\sqrt{2}))$$

Page 118	Final paragraph	In the description of the direction of $\hat{\mathbf{n}}$ in the right-hand grip rule the sentence should have referred to the direction that the thumb points, so that the sentence should read:
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The direction of $\hat{\mathbf{n}}$ is the direction in which the thumb points in Figure 29(a) when the fingers are turned from **a** towards **b** through the angle θ .

Page 138	Exercise 35(e)	Part (e) has a problem as the sack will start moving horizontally before it loses contact with the floor. This will change the angle of the rope, which invalidates the argument presented in the solution. Part (e) of this question should be deleted.
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Page 158	Solution to Exercise 23(e)	In the final step of the solution there is a sign error in the second term, which means that the final solution is incorrect. The final line should read:
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$$= \mathbf{0} - \mathbf{a} \times \mathbf{b} - \mathbf{a} \times \mathbf{b} + \mathbf{0} = -2\mathbf{a} \times \mathbf{b}$$

Page 160	Solution to Exercise 29	In the penultimate line of the solution there is a sign error in the first term ($-\frac{1}{2}\mathbf{i}$ should be $\frac{1}{2}\mathbf{i}$), which is corrected in the final line. The penultimate line should read:
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$$= -15g \times \frac{1}{2}\mathbf{i} + 15g \times \frac{\sqrt{3}}{2}\mathbf{j}$$

Page 161	Solution to Exercise 31	In the diagram showing the mechanical system the block should be labelled as 0.5 kg rather than 5 kg.
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Unit 3

Page 208	Solution to Example 7(a)	In line 11 of page 208 the constant C_1 should be a lower case c_1 , so line 11 should read:
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convenience writing $k = c_1 D/m$, gives

Page 230 Solution to Exercise 3(c) In the final sentence of the first paragraph we implicitly use the fact that the particle starts from rest and it would be better if this usage was explicit. The revised sentence could read:

So the ‘area’ under the graph gives us the change in velocity, which is equal to the velocity in this instance as the particle starts from rest.

Page 246 Solution to Exercise 21 In the third paragraph where the assumptions are stated there should be a statement about how air resistance has been modelled. After the sentence stating that we model the toboggan as a particle, insert the following sentence:

We model air resistance using the quadratic model acting on a smooth sphere of effective diameter 5 cm.

Unit 4

New Page 40 Paragraph before Exercise 33 At the end of the first sentence in the paragraph before Exercise 33 the indices should be 0 and 1 rather than 1 and 2, so the end of the sentence should read:

... the vector $\mathbf{y}$ contains the given values y_i ($i = 0, 1$).

Page 45 Margin note alongside Figure 10 The vectors appearing in equation should be $\mathbf{x}$ rather than $\mathbf{b}$, so that the margin note should read:

Vector positions for the vertices of the parallelogram are $\mathbf{x} + \delta\mathbf{x}$, namely $\begin{pmatrix} 3 \\ 2 \end{pmatrix} \pm \begin{pmatrix} 3.9 \\ 2 \end{pmatrix}$ and $\begin{pmatrix} 3 \\ 2 \end{pmatrix} \pm \begin{pmatrix} 0.1 \\ 0 \end{pmatrix}$.

Page 59 Solution to Exercise 22(b) In the diagram the colours of the red and blue vectors on the right hand set of axes should be interchanged to indicate that the vector $\mathbf{i}$ maps to $(3 \ 1)^T$ and $\mathbf{j}$ maps to $(2 \ -6)^T$.

Unit 5

New Page 75 Figure 5 In the final row of the table shown in Figure 5 the last two columns should be interchanged, so that the table finishes:

	No real eigenvectors	No real eigenvalues
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Page 116 Solution to Exercise 7 Change the second occurrence of eigenvalue to eigenvector, so that the middle of the sentence reads:

... and $(1 \ 0)^T$ is an eigenvector of $\mathbf{A}$...

Unit 8

Page 33 Solution to Exercise 2(d) There is a typographical error in the displayed equation, the first k should be an r , so that the equation should read:

$$c(t) = \frac{q}{r} + \left(c(0) - \frac{q}{r} \right) e^{-kt}.$$

Page 35 Solution to Exercise 5(c) There is a typographical error in one equation for the weight $\mathbf{W}$ of the particle, the $\mathbf{i}$ should be a $\mathbf{j}$, the corrected equation should read:

$$\mathbf{F} = |\mathbf{F}|(-\mathbf{i}), \quad \mathbf{N} = |\mathbf{N}|\mathbf{j}, \quad \mathbf{W} = mg(-\mathbf{j}).$$

Unit 9

Page 50	Paragraph above Table 1	In the second sentence in the paragraph above Table 1 change ‘three,’ to ‘two’, so that the sentence reads: It also shows the magnitudes of the weights corresponding to n nuts, to two decimal places.
Page 65	Paragraph below Equation (10)	The range for the phase angle ϕ should not include $-\pi$, so the final sentence should finish: ... lies in the interval $(-\pi, \pi]$.
Page 75	Box defining kinetic energy	The quantity v should be the speed of the particle rather than a component of velocity, so the definition should read: The kinetic energy T of a particle of mass m moving with speed v (for one dimensional motion $v = \dot{x}$) is given by $T = \frac{1}{2}mv^2 = \frac{1}{2}m\dot{x}^2$
Page 87	Two lines from bottom	There is a minus sign missing in the given equation for λ, the end of the first sentence should read: where A and B are arbitrary constants, and $\lambda = \sqrt{-U''(x_{\text{eq}})/m}$.
Page 88	Line above Exercise 33	There are two factors of t missing from the exponents of the general solution. The corrected equation should read: $x = Be^{\sqrt{6/m}t} + Ce^{-\sqrt{6/m}t} + x_{\text{eq}}$
Page 100	Solution to Exercise 16	There is a minus sign missing in the final line on page 100. This line should read: This is sketched below (where $\phi/\omega = -\pi/4/20 \simeq -0.04$).
Page 105	Solution to Exercise 19	In the final sentence of the answer to part (a) the inequalities should include the end points as the expression for the buoyancy force is valid for $x = 0$ and $x = h$, so the end of the sentence should read: ... is valid for $0 \leq x \leq h$.
Page 107	Solution to Exercise 23	There is a misplaced bracket in the final displayed equation of the solution, the equation should read: $U(x) = -A\rho g(hx - \frac{1}{2}x^2) + \frac{1}{2}A\rho gh^2 = \frac{1}{2}A\rho g(h - x)^2.$
Page 107	Solution to Exercise 24	Midway through the solution there is a typographical error where l_0 appears as 0 when discussing the datum for the potential energy function. The sentence should read: The given datum is $x = l_0$, so $U(l_0) = 0$, thus $C = 0$, and we have

Unit 10

Page 154	Displayed equation between Equations (21) and (22)	Add a close parenthesis to the second term on the left-hand-side of the equation, so that the equation reads: $(Pr\Omega)^2 + (P(k - m\Omega^2))^2 = P^2((k - m\Omega^2)^2 + r^2\Omega^2),$
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Page 158	Resonance frequency box	The box should mention that the resonance frequency is given by β times the natural frequency, so the first sentence should begin: The frequency at which resonance occurs is given by $\beta \omega$ where ω is the natural frequency and
Page 169	Solution to Exercise 7(a)	In the first sentence the length of the damper l should be $l_0 + x$ and not x, so that the end of the sentence should read: ...so that $l = l_0 + x$ and $\dot{l} = \dot{x}$.

Unit 11

Page 190	Solution to Example 3	In the displayed equation for $\mathbf{T}_3$ two lines above Figure 13 the angles should be θ_2 rather than θ_3, so the equation should read: $\mathbf{T}_3 = - \mathbf{T}_3 \sin \theta_2 \mathbf{i} + \mathbf{T}_3 \cos \theta_2 \mathbf{j}$
Page 196	Solution to Example 4	In first inline equation in the first sentence of the solution the right hand side should be a zero vector instead of zero, so the middle of the sentence should read: ..., so that $\dot{\mathbf{x}}(0) = \mathbf{0}$, ...
Page 200	Figure 19	The two springs should be labelled as being of stiffness k_1 and k_2 rather than both being of stiffness k. The top row of text in the figure should read: $k_1, l_{1,0} \quad k_2, l_{2,0}$
Page 226	Solution to Exercise 7(b)	In the penultimate displayed equation the parenthesis is misplaced in the final term. The displayed equation should read: $\mathbf{x}(t) = C_1 \mathbf{v}_1 \cos(\omega_1 t + \phi_1) + C_2 \mathbf{v}_2 \cos(\omega_2 t + \phi_2)$
Page 231	Solution to Exercise 11	On lines 3 and 4 of the solution change spring to string, so that the sentence reads: Instead of the mass of the whole string, 0.25 g, we substitute half the mass of the string, 0.125 g, ...

Unit 12

Page 41	Solution to Example 8	Change $\dot{y}$ to $\dot{x}$ in the penultimate sentence of the paragraph following Figure 25, so that the sentence reads: So the sign of $\dot{x}$ must be negative along the whole length of this nullcline.
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Unit 13

Page 73	Displayed equations after Equation 10	There is an extra factor of n in the arguments of the cosine terms in the expressions for $G_1(t)$ and $G_2(t)$, the corrected equations should read: $G_0(t) = A_0,$ $G_1(t) = A_0 + A_1 \cos t,$ $G_2(t) = A_0 + A_1 \cos t + A_2 \cos(2t),$
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Page 87 Equation 30 In the first line of the displayed equation there should be plus rather than minus before the summation sign, so the first line should read:

$$W(t) = \frac{\tau}{4} + \frac{\tau}{\pi^2} \sum_{n=1}^{\infty} \frac{(-1)^n - 1}{n^2} \cos\left(\frac{2n\pi t}{\tau}\right)$$

Page 102 Solution to Example 12 In the final displayed equation the arguments of the sine functions should be a fraction with T in the denominator, so the final equation should read:

$$F_{\text{odd}}(t) = \frac{4}{\pi^2} \left(\sin\left(\frac{\pi t}{T}\right) - \frac{1}{3^2} \sin\left(\frac{3\pi t}{T}\right) + \frac{1}{5^2} \sin\left(\frac{5\pi t}{T}\right) - \frac{1}{7^2} \sin\left(\frac{7\pi t}{T}\right) + \cdots \right).$$

Page 104 Solution to Exercise 7(b) The graph plotted in the solution is $h(-t)$ not $h(t)$ as the graph indicates.

Unit 14

Page 133 Displayed equation below equation (10) The limits of integration should be from -1 to 1 instead of the $-\pi$ to π and the denominator of the fraction outside the integral should not contain π , so the corrected equation should read:

$$a_n = \frac{2}{\pi} \int_{-1}^1 \sin(2\pi x) \sin(n\pi x) dx.$$

Page 143 Figure 10 In the figure caption it should state that the plot is of the wave equation rather than the damped wave equation, so the caption should end:

(b) The solution $u(x, t)$ of the wave equation plotted as a surface.

Page 149 Figures 12 and 150 The lower case thetas in the diagrams should be upper case thetas.

Page 153 Solution to Example 6 On line 15 there is a minus sign missing (the separation constant μ should be negative), so the beginning of the line should read:
With $\mu = -n^2\pi^2/L^2, \dots$

Unit 15

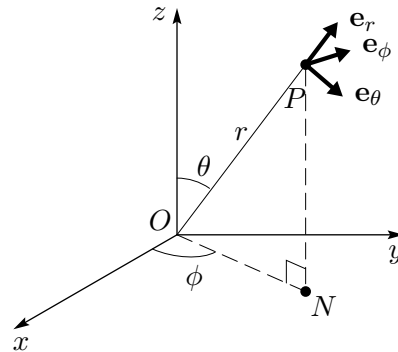
Page 15 Solution to Example 2 In the line above the second displayed equation the equation defining vector $\mathbf{r}$ should have $\mathbf{j}$ instead of $\mathbf{i}$ in the second term, so that the line should begin:

Now $\hat{\mathbf{r}} = \mathbf{r}/|\mathbf{r}|$, where $\mathbf{r} = x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$

Page 31 Solution to Example 7(b) In the first displayed equation an extra term $3\rho^2$ erroneously appears, the correct equation should read:

$$x^2 + y^2 + 3 = \rho^2(\cos^2 \phi + \sin^2 \phi) + 3$$

In Figure 30 there is a construction line from the point N to the y -axis that should be omitted and the marked right angle should be the angle ONP . There is another superfluous construction line from the point P to the z -axis. In addition the $\mathbf{e}_\phi$ unit vector should be pointing in the direction of increasing ϕ . The correct diagram should be:



Unit 16

Page 61 Highlighted result In the first line the vector field $\mathbf{F}(\rho, \theta, z)$ should be $\mathbf{F}(\rho, \phi, z)$, so the first sentence should start:

The **divergence** of a vector field $\mathbf{F}(\rho, \phi, z) = F_\rho \mathbf{e}_\rho + F_\phi \mathbf{e}_\phi + F_z \mathbf{e}_z$

Page 107 Solution to Exercise 18(c) The printed solution does not fully answer Exercise 18(c) as it does not say anything about the direction of **curl v**. An extra sentence should be added that reads:

The direction of **curl v** is the same as $\boldsymbol{\omega}$, which is the direction that gives the sense of rotation of your home.

Page 109 Solution to Exercise 23 In the second line of the displayed equation there is a term $\cos^2$ that should be $\cos^2 t$, so that the second line should read:

$$= \int_0^{\pi/2} (-8 \sin t \cos t - 4(\sin^2 t + \cos^2 t)) dt$$

Unit 18

Page 14 Unnumbered displayed equation In the second term on the right the numerator of the first fraction should be δx_2 instead of δx_1 , so that the equation should read:

$$\frac{\delta y}{y} = \frac{\delta x_1}{x_1} \left(\frac{x_1}{y} \frac{\partial y}{\partial x_1} \right) + \frac{\delta x_2}{x_2} \left(\frac{x_2}{y} \frac{\partial y}{\partial x_2} \right) + \dots \frac{\delta x_n}{x_n} \left(\frac{x_n}{y} \frac{\partial y}{\partial x_n} \right).$$

Page 41 Top of page There should not be a minus sign on the right-hand side of the second equation. The corrected equation should read:

$$\frac{\lambda}{L} \frac{\partial L}{\partial \lambda} = \frac{2\lambda}{\lambda^2 - 1}.$$

Page 53 Solution to Exercise 4(b) The second paragraph of the solution was written for a 1% increase in u rather than the 5% increase stated in the exercise. The second paragraph should read:

Thus an increase of u from 20 to 21, a 5% increase, results in a $1.9 \times 5\% = 9.5\%$ increase in the distance, which is approximately 4 m.

Page 53 Solution to The final paragraph of the solution should be in parentheses as it
Exercise 4(b) a comment that was not required to answer the question and in
addition the magnification should not be divided by 5, so that the
final paragraph should read:

(Since the magnification of the relative change in u to the relative
change in x is approximately 1.91 is small we can conclude that the
model, for this set of data, is relatively insensitive to changes in the
launch speed.)

Unit 19

Page 95 Example 7 In the first line of the displayed equation following equation (29)
there is a | misssing from the first term on the right-hand-side, which
should read:

$$\frac{1}{2}mu^2 = \frac{1}{2}m|\dot{\mathbf{R}}_1|^2 + \frac{1}{2}m(\sqrt{2}V)^2$$

Unit 20

Page 152 Exercise 24(c) In the first unnumbered displayed equation the expression in the
brackets should be a range for θ rather than a false statement, the
equation should read:

$$9 \cos \theta + 3 \sin \theta = 4\sqrt{2} \quad (0 < \theta < \pi/2).$$

Unit 21

Page 243 Solution to There is an extra close parenthesis in the first term of the
Exercise 27 penultimate displayed equation, the equation should read:

$$\mathbf{\Gamma}^{\text{rel}} = (-R\mathbf{j}) \times (-|\mathbf{F}|\mathbf{i}) = -R|\mathbf{F}|\mathbf{k},$$